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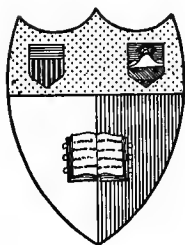
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Orange culture in the Punjab.



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ORANGE CULTURE

IN THE

PUNJAB.



Lahore :

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PREFACE.

IN writing this pamphlet on Orange Culture, I have not attempted to compile a complete treatise on the subject. My aim has been to place in the hands of the amateur a cheap and handy reference dealing with the conditions as to climate, site and soil ; and giving in simple and concise language instructions and information on the various methods of propagation, the selection of stocks, the lay-out and planting of the orchard, on irrigation, the application of manures and fertilizers, and on pruning, such instructions and information being applicable to the Punjab. To this I have added a short chapter on insect pests and diseases, with suitable and easily-applied remedies.

As an appendix, I have included a few notes on the "classification" and "botanical characteristics" of the Citrus family, trusting that the information contained therein will prove sufficiently interesting and instructive to justify its inclusion in this little book.

A. HARDIE.

ORANGE CULTURE

IN THE PUNJAB.

ESSENTIAL CONDITIONS.

Climate, site, soil and water supply are important factors in determining the success or failure of every fruit garden. With reference to the climatic requirements of the Orange Family Professor Rolf in the "Farmer's Bulletin" says:—"in all regions where the temperature does not fall below 18° above zero nor rise above 100 F., under humid conditions, and where there is sufficient moisture, Citrus fruits may be produced. The rainfall should not be excessive, certainly not more than 50 to 70 inches annually, and the winter temperature should not go below 26° to 27° F. of continued cold." In the Punjab plains, however, Citrus orchards are frequently subjected to a higher temperature than the limit given by Professor Rolf—and this sometimes under humid conditions—and little if any harm accrues. As to excessive rainfall, the Punjab grower has nothing to fear, except on those rare occasions during the monsoons when successive heavy falls occur at intervals of a few days.

Intimately connected with climate is the factor of elevation. Although members of the Citrus family are found at higher altitudes than 2,500 feet, this should be taken as the limit, more especially if the orchard is to be planted—as it should be—as a profit-yielding concern.

During the flowering period and when carrying the fruit crop, Oranges suffer considerably from boisterous winds. In selecting the site, therefore, preference should be given to a position, other conditions being favourable, which is sheltered by belts of trees. In the absence of such protection wind-breaks can, and should be, established along the boundary lines of the plantation by putting down hedges of Mulberry, Phulai, Guava, Khatta or Bamboo.

Another important desideratum in the matter of site is that it should be within easy reach of a railway station, or, in the case of sending the produce direct to market by road, where facilities exist for quick transport. This in order that the fruit may reach its destination in good condition.

A rich, loamy soil containing plenty of lime, and in such condition as to absorb water rapidly, is essential to success. Land where an impervious stratum of kankar or clay is found, even at a depth of 3 or 4 feet, is unsuitable, and should be avoided. On the other hand, soil of a sandy, porous nature, in addition to being deficient in plant foods, is apt to favour physiological and other diseases. Unfortunately, Punjab soils generally are deficient in humus, that black substance which results largely from the decay of plants and other organic matter, and which is so essential to plant life. Where, therefore, this substance is non-existent, or exists in such diminished quantity as not to meet the requirements of plants, the missing compounds must be replaced. This is best and most quickly effected by liberal applications of cow and stable manures, which contain a high percentage of that matter which is necessary to creation of the humus condition.

It is almost superfluous to add that on the plains of the Punjab where even the normal rainfall is insufficient, to say nothing of its uneven distribution with reference to season, a reliable source of good water for irrigation must exist.

PROPAGATION.

Citrus trees may be propagated by seeds, cuttings and layers, and by budding and grafting. In commercial orchards and nurseries, however, the last two methods only are practised. The Khatta and Khatti ("sour stock") are propagated generally by seeds, and occasionally by cuttings; Oranges, commercially, by budding and grafting, and experimentally, by seeds; Pome-loes (Chakotra) usually by grafting—not often by seeds; Citrons (Galgal and Mokri) by cuttings and budding—seldom by seeds; Kaghzi limes, by cuttings, seeds and layers; Sweet Limes, by cuttings only.

Seeds.—The easiest, and of course most natural, method of propagation is by seeds, but this plan is unsatisfactory. The seeds of the Citrus, as of many other plants, cannot be relied upon to reproduce the variety from which they were taken, and for this and other reasons the seedling Orange has ceased to be desirable as a commercial fruit. Almost any seedling Sweet Orange, given proper care and cultivation, will produce edible fruit, but such fruit has no uniformity as to size, thickness of rind, flavour, number of seeds, and other essential characteristics.

Fruit selected for seed should be of fair size, good shape, and be fully ripened. The method employed for the extraction of the seed from the pulp is immaterial; most *malis* prefer to pick it out singly by hand. A peculiarity about Citrus seed, which it is important should be borne in mind, is that it must never be allowed to become dry to the extent of brittleness. Obviously the best plan for preservation is to retain the seed in the fruit itself until required for sowing, but where this is impracticable it can be kept in good condition by storing in slightly moistened sand.

To raise seedlings the most convenient method is to sow the seed in 8-inch pots, using a compost of two parts loam or canal silt, one part leaf-mould and one part sand. The soil should be made moderately firm and the seeds—40 to 50 to a pot—sown on a level surface and covered to a depth of not more than half an inch. A thin sprinkling of pure sand, in addition to the covering of soil, will do much to prevent "damping-off," which is a frequent cause of loss after the seedlings are 2 to 3 inches high. Should the grower elect or be obliged to sow in the open ground a plot of good soil should be chosen, the ground broken up to a depth of at least 1 foot and reduced to a fine tilth, then divided into beds, say, 6 feet long by 4 feet wide. The beds should then be given a thorough soaking. After watering, and as soon as the soil is in a workable condition, the beds should be raked over, making an even surface, the seed sown broadcast and covered as advised above. The sowing season may be taken to extend from the beginning of February to the end of March. Provided weather conditions be favourable the seed will germinate in about three weeks.

The site selected for the nursery should have a soil of good depth and texture, and possess efficient natural drainage. Light, sandy or gravelly soil is unsuitable, not only on account of its lack of humus but also because such material is hopeless for a soil-ball or *gachi*, with which eventually the plants have to be lifted. About a month before the probable date of setting out the seedlings the ground should be prepared, *i.e.*, deeply dug, levelled and well watered. For the sake of convenience in subsequent weeding, hoeing and irrigation it is advisable to divide the required area into strips or beds, say, 6 feet wide; the length is immaterial provided it be not so great as to prevent equal distribution of water. In setting out the seedlings the correct distances apart are 18 inches between the rows (4 rows to a bed), and 12 inches in the rows. These intervals admit of the development of healthy young trees and allow for *gachis* of adequate size. (Indian *malis* are addicted to the habit of putting down the maximum number of plants in a given space, and seem to forget the important fact that the plants must one day be lifted with soil-balls containing sufficient roots to ensure success when planted in the orchard.) Care should be taken that seedlings are not planted deeper than they were in the pots or seed beds, deep planting being liable to cause "collar rot." All weak and inferior seedlings, which are unlikely to produce healthy stock, should be discarded. Two years from the date of planting in the nursery beds the seedlings will be ready for budding or grafting, as the case may be. During this period all the

attention needed will be watering (say, twice monthly during the dry hot weather and once a month in the cold season) and occasional stirring of the surface with the *kurpi* to effect aeration of the soil and conservation of moisture.

Cuttings.—Cuttings are made from well-matured, two-year old wood, having 3 or more buds or 'eyes,' and are inserted during December—January when growth is practically dormant. They should be 6 to 8 inches long, a quarter to half an inch thick, and be selected as far as possible from straight portions of wood having a uniform thickness. At the lower end they are cut immediately below a bud, for the simple reason that all cuttings produce roots most readily from a joint; at the top, a little above the highest bud which it is proposed to retain. The cuts should be made clean across—not in a slanting direction—with a sharp knife. Any other implement is liable to leave ragged edges, which, at the lower end, will prevent the formation of cambium and ultimately result in decay of the wood. Beds of a suitable size having been prepared, the cuttings should be inserted 12 inches apart, both between and in the rows, taking care that the base of each cutting is in firm contact with the soil, and that the material is pressed moderately firm all round. The cuttings will require no attention beyond watering and keeping free from weeds till the following spring, i.e., about 14 months after insertion, when they will be sufficiently rooted to lift and replant in their permanent quarters.

Layers.—Layering is a method of propagation by which a branch, being placed in contact with the earth, is made to throw out roots and thus produce an independent plant, the branch remaining attached to the parent plant during the process.

Of the Citrus family the *Kaghzi* lime is the only member which it is usual to propagate by layers in the Punjab, and the operation is performed at the beginning of the rains either direct in the ground or in 8-inch pots.

To prepare the layer, cut the stem half-way through just below a node or joint, then slit the stem upward through the node and beyond, making the total length of the cleft $1\frac{1}{2}$ to 2 inches. A small pebble or piece of charcoal if placed in the cleft will ensure its remaining open. Bend down the cut portion to the ground, or pot as the case may be, and fix a peg over the branch and below the point of incision. The end of the shoot is then bent nearly vertically and soil packed over the cut and round the shoot to keep it in position. About two months after layering roots will begin to form, when a notch may be cut in the stem an inch or two below the cleft. A week later cut the notch deeper and finally, about three months from the date of layering, the layer may be completely severed from the parent plant.

Budding.—This is practically a form of grafting, the only difference being that a bud is used instead of a stool. Budding operations may be commenced as soon as the sap begins to flow freely, say, at the beginning of March, and be continued up to the middle of April. But wherever possible all budding should be finished by the end of March. The buds should always be selected from well-matured, round wood that is free of thorns and of the previous year's growth. They should be fairly plump and healthy, and not too far advanced in growth. Bud wood having been selected and cut into convenient lengths it must, if removal of the buds and actual insertion in the stock cannot at once be taken in hand, be preserved in water to maintain the flow of sap.

To remove a bud, commence half an inch below it and cut upwards in a semi-circular manner to half an inch above it. Turn the bud over, then with the point of the knife and thumb nail seize the wood just under the bark at the upper end and pull gently. If the wood comes away without any cone, and no hollow is left at the base of the bud, the bud is perfect, otherwise discard. Cut off the leaf, leaving about an inch of stalk.

On the tree to be budded a vertical cut about $1\frac{1}{2}$ inches long is made in the bark a few inches from the ground. At the base of this incision a horizontal cut is made, giving the knife an upward twist slightly to raise the lower edge of the bark. The cuts should be perfectly clean, a ragged edge being liable to cause partial decay and adversely affect the union. The bud should be inserted from below through the horizontal incision, with the eye pointing upward, and pressed up with the point of the knife until fully

covered by the bark. A ligature is then tightly tied above and below the bud to hold it in place and to exclude air until the union is formed. Bands of raffia, soft cotton or *san* about 10 inches long make suitable tying material. As soon as the bud has united with the stock the ligature should be cut in order to prevent girdling—that is, undue checking of the flow of sap. About a fortnight after setting the buds examine them to see whether they have united with the stocks. If they are still green, and a grayish line of new growth is seen where the incisions were made, it may be assumed that a union has been effected. If so, cut off, or partly cut off, the stock a few inches above the bud, and the latter will soon begin to expand and grow.

The buds should all be set on that side of the trees which is least exposed to the extreme heat of the afternoon sun, and placed not less than 6 inches above the ground level in order that the unions, when the plants are eventually set out in the orchard, may not come in contact with the soil.

Grafting.—There are various forms of grafting, but in the case of Citrus plants inarching, or, in other words, grafting by approach, is the only method adopted in general practice. The season for the operation begins with the flow of sap in the spring and ends with it in the autumn; and the stock intended for inarching must be a pot plant that may be taken to any place desired. The operation itself is performed by making with a sharp knife a longitudinal cut 2 to 3 inches on the stem of the stock, a similar cut on the twig to be inarched, bringing the two cut surfaces together and binding them with cotton twine or raffia. Great care should be taken that the diameter of the stock and scion are the same, so that when the cut surfaces are brought together they may fit correctly.

About a month after the operation is performed, cut a small notch in the scion just below the union and another in the stock just above it. A month later the lower notch may be made a little deeper, and the top of the stock cut away. Three months from the date of inarching the plant can, as a rule, be severed from the tree.

Watering of the stocks must be regularly attended to, for if this be neglected the result will be slow formation of the union and a weak graft.

SELECTION OF STOCKS.

“The qualities that determine the value of a certain stock are vigour, resistance to certain diseases, its influence on the scion with respect to productivity and quality of the fruit produced, and also to some extent its influence with respect to the habit of the top.”

No one particular kind of stock for Citrus trees can be said to be best suited to all conditions of climate and soil. In Lucknow, for example, the ‘Khatta’ is the most suitable stock; in Baroda, the sweet lime. For the Punjab generally the most important stocks, mentioned in the order of their suitability and usefulness, are—

- (1) ‘Khatti’ (for Maltas, other Sweet Oranges, Lemons and Pomeloes)
- (2) ‘Mittha Nimbu’ (for ‘Santaras’ and Maltas)
- (3) ‘Khatta’ (for ‘Santaras’)
- (4) ‘Mokri’ and ‘Galgal’ (for ‘Santras’ and Maltas)

On account of its deep rooting system and vigour, its resistance to the effects of alkali, to root rot and gummosis (gumming), the ‘Khatti’ has long been considered the standard stock in North-West India. Maltas grown on this stock are abundantly fruitful. The fruit, though somewhat thick-skinned, is juicy, large, globular and of excellent colour.

The Sweet Lime, or ‘Mittha Nimbu’, has a well-developed root system and in rapidity of growth is equalled only by the Pomelo and ‘Mokri’. It succeeds well in light, dry soils, and is acknowledged to be the best all-round stock for the ‘Santara’. Paradoxically, a Malta budded on a Sweet Lime produces a weak, dwarf tree. True, the fruit—which is oval-shaped, thin-skinned and lemon-coloured—is of excellent quality; but it is sparsely borne, and for this reason the ‘Mittha Nimbu’ is not recommended for the Malta, except on a small scale for the sake of variety.

Maltas on the 'Khatta', or Sour Orange, produce trees of small size which lack vigour, and are otherwise unsatisfactory. 'Santaras,' on the other hand, do tolerably well on the 'Khatta,' though of course the results are not nearly so good as when this variety is budded on the Sweet Lime.

Of all the stocks used in the Punjab the 'Mokri' and 'Galgal' (Citrons) are of the least value. On these stocks, it must be admitted, the 'Santara' grows fairly well, but the fruit produced thereby is exceedingly poor. For the Malta the Citron is unsuitable in every respect. Growth at first is rapid (which accounts for the extensive use of this stock by dishonest nursery men), but the tree produced assumes at an early stage a straggly, uncertain habit. It is an easy prey to all the diseases to which the Citrus family are susceptible and, as rule, is short-lived. Briefly, Maltas grown on the Citron are practically worthless.

THE ORCHARD.

Preparation of the ground.—Healthy, symmetrical growth of the trees depends largely on the initial preparation of the ground, and no pains should be spared in the performance of this important operation. If the land be of a heavy, retentive nature it should be dug or 'trenched' to a depth of $2\frac{1}{2}$ feet and a liberal supply of brick kiln refuse, old demolition mortar or sand incorporated in the process, the object being to create porosity. Light, sandy land, which is deficient in plants foods, requires similar treatment, with the difference that instead of the materials mentioned, cow-dung in generous quantities should be added. Digging operations are best performed during the hot, dry season, and whether the soil be heavy or light it is advisable to leave the surface as rough as possible to permit of thorough aeration. Land which has been cultivated for a period of years, possesses good natural drainage and is of a friable, porous condition, need not necessarily be trenched: deep ploughing and cross ploughing will suffice.

These operations performed at the time advised, the rains will have settled and compacted the soil and rendered it in a fit state to receive the young trees, say, by the middle of August, at which time, if circumstances permit, planting may be taken in hand. Most growers prefer to plant in the spring, which is the better season. In either case, before setting out the trees the ground should be carefully levelled to ensure equal distribution of irrigation water.

Lay-out.—In laying out the orchard there are three main objects to be borne in mind—economy of space without undue crowding, symmetrical appearance and facility for future cultivation of the ground. There are various methods of arranging the trees, the most satisfactory, and only ones that need be dealt with here, being the square, the quinqux and the septuple.

By the square, which is the simplest and most commonly adopted method, the rows of trees intersect each other at right angles. This allows of cultivation being performed in two directions.

The quinqux, which is similar to the above except that a tree is planted in the centre of each square, should be adopted as a permanent arrangement only in those cases where the corner trees are to be set at not less than twenty-two feet apart. At shorter distances the system must be treated as temporary, the fifth or central tree being, for example, a Peach, which can be removed after six or seven years. In this case, of course, the quinqux simply reverts to the square.

By the septuple system the trees are set equidistant from each other, six trees forming the angles of an equilateral hexagon with one in the centre, hence the term septuple. This arrangement admits of the ground's being more economically divided and more trees per acre planted at a given distance apart than by any other method.

As illustrating the systems referred to, and showing the number of trees per acre under each at various distances apart, respectively, the following diagrams and table will be found useful :—

Diagram I.
Square and Qinqux Systems.

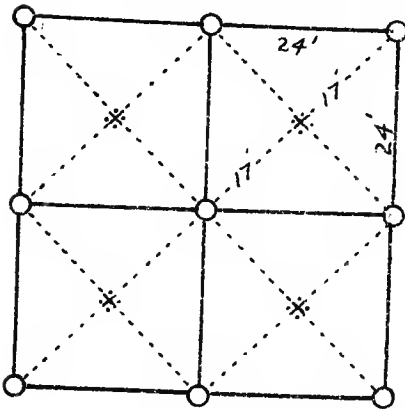
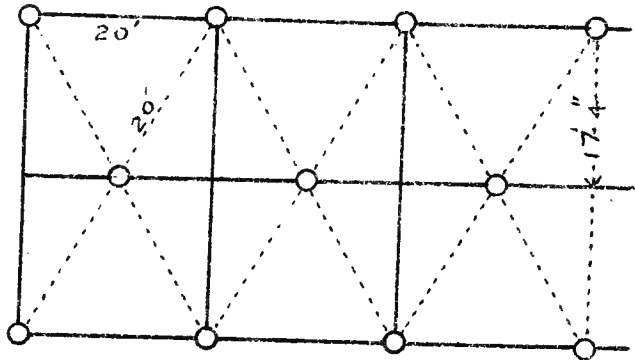


Diagram II.
Septuple System.



Distance apart.	TREES PER ACRE.		
	Square system.	Quinqux system.	Septuple system.
24' × 24'	64	113	75
22' × 22'	81	145	94
20' × 20'	100	181	114
18' × 18'	121	221	137
16' × 16'	144	265	173
15' × 15'	169	313	200

N. B.—In applying the figures of the first column to those of the third it must be remembered that the distance refers to that between the trees represented by small circles (Diagram 1), and that the figures of the third column include the trees represented by asterisks.

For Citrus trees in the Punjab the following distances apart are recommended :—

Malta, Washington, Navel, Valencia, 'Khatta' and 'Khatti' —18' × 18' to 20' × 20'.

'Santara' —16' × 16'.

Pomelo—20' × 20' to 24' × 24'.

Sweet Lime, Lemon and Citron —16' × 16' to 18' × 18'.

'Kaghzi' Lime—15' × 15' to 16' × 16'.

Planting.—Planting may be done during August—September or February—March. Some authorities hold that trees planted in the autumn do little more than recover from the operation before the advent of the cold weather. This is perfectly true of trees taken from the ground, as, in the process of lifting and planting, the roots of such plants must necessarily sustain a certain amount of damage. But young trees that have been grown in plots, if planted during or immediately after the rains, make considerable headway before the winter temperatures set in. Spring planting, however, is safer and generally preferable. At this season the plants are dormant; consequently they suffer little if any ill effects from the operation.

In the case of land that has been trenched preparatory to planting, the digging of deep, wide holes for the reception of the trees is unnecessary. By trenching, the soil has already been loosened and rendered friable, and a hole a few inches wider than the soil-ball or *gachi*, and big enough to admit of satisfactory ramming after the tree has been set in position, is all that is needed.

On the other hand, where the land has not been trenched, pits three feet wide by two and a half to three feet deep must be dug. This should be done a month or six weeks prior to the intended date of planting, and the soil of the pit left lying on the surface to ensure its being aerated and becoming wholesome. A week before planting, the pits should be filled in and the soil made firm by the simple process of treading with the feet. This treading, however, is not sufficient in itself: it is essential that the pits be thoroughly soaked, and any resulting subsidence which may take place made up before the trees are actually put down. Many fruit and other trees are lost through disregard of this elementary precaution.

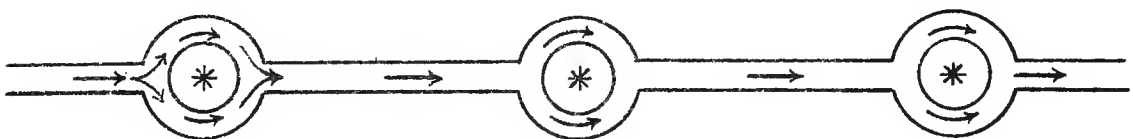
Care should be taken when planting to see that the soil is neither too wet nor too dry. Wet material packed round a soil-ball will ultimately become hard, thus interfering with the proper access of air and preventing free root development. Dry earth, on the other hand, results in loose planting, and renders impossible that close contact which is so necessary between root and soil. Though planting too deeply is another of the evils that must be avoided, it is difficult in the case of trees fit for planting in the orchard to adhere strictly to the advice of various writers that the soil-ball should be inserted no deeper than it was in the nursery. From a covering of two, or even three, inches no harm will accrue.

When the plants are taken from the open nursery, *i.e.*, with *gachis*, the shorter time elapsing between lifting and planting the better, as undue drying of the roots and soil-balls will result in tardy recuperation. It should also be borne in mind that all root-ends mutilated in the process of lifting will heal much quicker if dressed with a sharp knife.

Irrigation.—The question of irrigation is largely one in which observation and common sense must be the guiding factors. The amount of water needed naturally varies according to climatic differences, character of the soil and size of the trees. In the Punjab generally six to ten waterings per annum will suffice, the number depending on the amount of rainfall and the capacity of the soil to hold water. If the soil parts readily with its moisture, light but frequent applications will produce the best results; if it retains water well, heavy applications at longer intervals are best. In either case it is important to get the water as deeply into the land as possible, and to conserve it by cultivation, *i.e.*, by maintaining a loose surface mulch.

The most economical, and possibly most widely adopted, method of irrigation for fruit and other trees is that known as the basin system. This is simply a shallow hole or depression excavated round each tree, and the holes connected by channels along which the water is made to flow from tree to tree.

Citrus trees, however, are liable, especially during the first two or three years after planting, to what is termed the "collar-rot" disease, and this malady is definitely aggravated by a body of water remaining for several consecutive days in direct contact with the base of the tree stems, as it frequently does during the rains where the basin system has been adopted. A channel-ring system as per diagram below is, therefore, infinitely better:—



This is merely a modification of the basin principle, the difference being that the basin contains, as it were, an island, in the centre of which the tree is planted. The water flows round the ring, reaches the roots of the tree by seepage and does not come into contact with the stem. The channel-rings and connecting channels should be nine to twelve inches wide and five to six inches

deep. For newly-planted trees the ring, or island, need not be more than two-and-a-half feet in diameter, but this should be increased annually as the tree develops. In other words, the diameter of the irrigation ring should be increased, taking the outer spread of the branches as a guide. *E. g.*, a tree whose outer branches are three feet from the stem should have a ring six feet in diameter. In this way the water is applied directly over the feeding roots, these being approximately at the same distance from the stem as the outer spread of the branches.

The channel and ring system of irrigation should be continued for a period of eight to ten years, or until the trees have attained full growth, after which the channels may be dispensed with and the water applied broadcast.

Cultivation.—During the first five or six months the young trees will require little attention except weeding and stirring of the circles in which they are set. Too much importance cannot be attached to the keeping clean of the orchard. All weeds, and especially grass, are injurious in that they draw from the soil much of the plant foods and moisture that are necessary to the young trees, and regular forking up of the soil is necessary in order to prevent the moisture from evaporating too quickly. In compact soils the moisture rises to the surface and therefrom evaporates by the heat of the sun; with a loose surface mulch it rises to the pulverised layer only. But this is not the only benefit that accrues: periodical breaking up of the surface also encourages root action and consequent rapid development of the trees.

The land between the rows of trees should be deeply ploughed at least once annually in order to prepare it for the admission and retention of as much of the summer rainfall as possible. This may be done at any time after the crop is gathered or before the advent of the monsoon. Ultimately, of course, the spread of the branches will prevent the free passage of bullocks and plough, when recourse must be had to the *kahi*.

The growing of crops and vegetables between the lines is not recommended, as such vegetation usually requires water more often than is good for the trees. Oranges, like other fruit trees, prefer undisputed possession of the land. Where, however, the soil is deficient in humus or nitrogen the cultivation and ploughing-in of such leguminous crops as *shaftal*, *berseem* and *san* are beneficial, in that they promote the action of those soil bacteria which render plant food available. *Shaftal* and *berseem* may be sown in the last week of September or first week of October at the rate of forty pounds to an acre, and *san*, during July—August, at twenty to twenty-four pounds to an acre. *Shaftal* and *berseem* are more economical than the last named, inasmuch as at least two crops of these can be cut for fodder, and the third or fourth only ploughed in as a green manure.

Manures and Fertilizers.—Nothing is of greater importance nor requires better judgment than the proper application of manures and fertilizers. No hard and fast rules can be laid down, for the practice must be constantly varied according to the character of the soil, the age and condition of the trees and the weight of the crop carried.

To amateurs it will be interesting in the first place to note the source of supply of the different elements and the nature of some of the more common manures. Nitrate of soda, hoof and horn, soot, sulphate of ammonia, urine and dried blood supply nitrogen only. Basic slag, superphosphate and bone dust supply phosphates. Kainit, sulphate and muriate of potash and wood ashes supply chiefly potash.

Horse dung is very useful as it contains all the three essential elements, namely, nitrogen, phosphates and potash, and is particularly suitable for heavy and loamy soils. By its use the soil particles are lightened and rendered more friable and easily accessible to air, warmth and water. Where, however, horse dung is depended upon as the main element of fertilization liberal dressings of potash should be occasionally applied to correct the evil of nitrogen in excess.

Cow manure is cooler and denser in texture than the former. It binds the particles of soil and enables it to retain moisture for a long time, and is suitable for light, sandy land.

A compost of vegetable refuse and dead animal matter, including blood, forms a rich manure after lying for a period of twelve months. Decay of the mass is accelerated if it be turned over twice or thrice.

Lime is very useful for certain soils. Mechanically, it renders hard and clayey soils friable, while it binds together the particles of light soils. Chemically, it sweetens the acid in sour soils, enhances fertility and sets free potash. Ammonia is liberated from the vegetable acids, thus causing the formation of nitrates. In its caustic condition it destroys the various insect and fungoid pests in the soil. To heavy or sour land it should be applied in caustic, and to light soils in fine chalk, form. Quicklime should be slaked and at once dug in. Ordinary ground lime is also very useful, and may be used at the rate of half-a-pound to the square yard.

Abundant applications of potash and phosphoric acid tend to promote fruitfulness, and to make for smooth, thin-skinned fruit of high quality. Nitrogen is the element which requires most care in its application. It promotes vigorous vegetative growth and gives the foliage a dark green colour, but this, in the case of a tree which has arrived at the bearing stage, at the expense of its fruiting propensities. It follows, therefore, that young, rapidly-growing trees which have not reached the bearing stage require relatively larger amounts of nitrogen and much less potash than those producing crops. The latter require a higher percentage of both potash and phosphoric acid in the mixture.

Pruning.—Unlike many other fruit trees the Orange does not require much pruning. In the earlier stages nothing more than the cutting back of over-vigorous shoots is necessary. Later, when the trees have reached the bearing age, crossing branches and such as are likely to touch the ground when laden with fruit should be cut out. Dead wood, if any, should also be removed, and superfluous sprouts from the trunks rubbed off. The aim should be to secure low-headed, symmetrical trees of upright growth, covered with a compact, but not too crowded, wall of leafage. With the Lemon rather more pruning is usually done, it being found that more and better fruit is produced if the top branches are cut back and the trees kept somewhat open in the centre. In the case of young trees the little pruning or “stopping” that may be necessary can be done at almost any time. Bearing trees, however, should be pruned immediately after the crop is gathered. Smooth cuts are essential to rapid healing of the wounds, and the cuts should be made as close as possible to the remaining part of the tree.

INSECT PESTS AND DISEASES.

A detailed and comprehensive treatise on the subject of insect pests and diseases is, of course, beyond the scope of this little book ; but it would be incomplete without some reference to the more common maladies to which Citrus trees are susceptible, and a few easily-applied remedies. It should be remembered, however, that “an ounce of preservation is worth a pound of cure,” which in this case means strong, vigorous trees—obtainable by strict attention to their needs. The stronger and healthier the less liable they are to attack.

Gummosis.—This is commonly known as “gum disease.” It is favoured by insanitary soil conditions close round the trees, such as imperfect drainage, excessive irrigation, water standing against the trunks, deep planting, and by injuries to the bark, which are frequently caused by careless manipulation of the cultivating tools. It is first recognised by the excretion of a gum-like substance oozing out near the ground. Later the bark about the infected part dries up and falls away in pieces.

The lower limbs of the affected trees should be cut away so as to allow of free circulation of air under them, the soil to a depth of four inches drawn away from the crown and the diseased bark removed with a knife or other sharp instrument. (Care should be taken to burn every fragment because of

the possibility of infection therefrom). In this condition the trees may be left for a few days, after which they should be re-examined. If the gum still exudes more cutting must be done, and so on till it ceases to flow. Then apply with a brush a solution composed of equal parts of crude carbolic acid and water. Manure of any kind should be used sparingly until it is certain that the disease has been wiped out.

Sooty mould.—This is the fungus which causes the blackened appearance of the leaves, fruit and twigs of the different species of Citrus, Mangoes, Guavas, etc. It does not live in the tissues of the plants, but draws its life from a sweet substance commonly called honey-dew, which is deposited by aphids and scale. It is nevertheless decidedly injurious to the welfare of the trees, the mouldy layer preventing the due performance of their natural functions, especially in the case of the leaves, and, until it is washed, rendering the fruit unfit for sale.

The remedy for the trouble lies in destroying the insects which produce the honey-dew, and one of the best insecticides for the purpose is Bordeaux mixture, the formula for which is as follows :—

Copper sulphate	...	...	4 lbs.
Unslaked lime	...	...	6 „
Water	...	...	50 galls.

Fill a 25-gallon barrel with water. Put the copper sulphate in a bag and suspend it by a rope in the barrel. Slake the lime in a small amount of water at first, then add sufficient to make it up to 25 gallons. The two ingredients should be stocked separately and mixed together when required, and in such quantity as may be necessary, using equal parts of both. To contain the mixture wooden vessels are best, as copper sulphate corrodes iron; to apply to the trees, use a brass syringe, which should be washed in hot water and soap immediately after use.

Die-Back.—The appearance of this disease is not due to any definite organism, but to abnormal conditions of the soil. It makes its appearance by the young shoots and leaves turning yellow. This is followed by reddish-brown stains and the dying-back for several inches of the new twigs. The tree makes repeated efforts to throw out new shoots, but these in turn also die-back, and the fruit cracks open and falls. The disease is usually attributable to the presence of hard pan or other conditions resulting in poor drainage. The too-frequent use of organic nitrogenous manures is also a prolific source of the trouble.

The grower should look to the condition of the roots and see that the ground is efficiently drained, and had better apply, for a time at least, chemical fertilizers only, using nitrate of soda and sulphate of ammonia as sources of nitrogen. The application of ordinary lime is also beneficial.

Purple scale.—This is said to be the most prevalent enemy of the Citrus family in America, as well as in certain parts of Europe. It has been seen occasionally in the Punjab, but here the depredations of the insect have not so far constituted a serious menace. It infests the leaves, fruit and bark, and may be readily recognized in the adult stage as a purplish body, in shape like an oyster shell.

The standard remedy for scale and sucking insects are the oil washes, the most common of which is kerosene emulsion. This is prepared as follows :—

Kerosene	...	...	...	2 gallons.
Soft-soap	...	...	...	8 ounces.
Water	...	...	...	1 gallon.

The soap, first finely divided, is dissolved in the water by boiling and immediately added boiling hot (away from the fire) to the kerosene. The whole mixture is then agitated violently while hot. Well made, the emulsion will

keep indefinitely. It should be used at the rate of two ounces to a gallon of water, and applied with a syringe.

Red Spider and Rust Mites.—These troublesome insects attack the leaves, frequently sapping the vitality of the trees to a serious extent. Their eradication is best effected by applying a sulphur and soda spray of the following strength, and prepared as indicated:—

Flowers of sulphur	...	...	...	20 lbs.
Soda, caustic (pulverised)	...	...	...	10 „
Water	...	...	...	20 gallons.

With a small quantity of the water mix the sulphur into a paste. Add the soda, which will cause boiling and the liquefaction of the mass. More of the water must be used gradually, to prevent burning, until the whole 20 gallons have been used. One gallon of this stock solution must be diluted with about 25 gallons of water before applying it to the trees.

APPENDIX.

CLASSIFICATION.

THE Citrus family belongs to the natural order Rutaceæ, of which it is considered the most important genus, on account of its edible fruits. The order comprises over eighty genera, many of which are indigenous to India. Botanists have expressed widely divergent views in regard to the true classification of the different Citrus fruits, but for practical purposes writers generally have adopted the classification worked out by Dr. Herbert J. Webber in the "Cyclopædia of American Horticulture." This classification, with certain minor modifications, is given in tabular form below :—

Botanical Species.	Botanical Varieties.	Horticultural Races.	Horticultural Varieties.
Trifoliata ...	...	...	The Deciduous Orange.
Aurantium ...	Amara ...	Sour Stock ...	Seville, Bitter Sweet, "Khatta,"
	Bergamia ...	...	Bergamot Orango.
	Sinensis ...	The Common Orange ...	Malta, Valencia, Washington, Navel, etc.
Nobilis ...	...	The Mandarin ...	"Satsuma," "Santara," China, Dancy's, Tangerine, King, etc.
Decumana ...	..	Pomelo ...	Red-fleshed, Sahsrampur.
		Shaddock ...	Paradise, Forbidden Fruit.
Japonica ...	...	Kumquat ...	"Nagami," "Narumi," etc.
Medica ...	Genuina ...	Citron ...	"Galgai," "Desi," "Mokri."
	Lemon ...	Lemon ...	Lisbon, Sicily, Eureka, etc.
	Acidâ ...	Lime ...	"Khatti," "Kaghzi" Lime, Sweet Lime.

Citrus trifoliata is the only Deciduous Orange; it is very ornamental and exceptionally hardy to cold. Its fruit, however, is not edible.

Citrus aurantium includes the Amara group, all the fruits of which are more or less bitter and hardly edible in the raw state. To this group belongs the well known 'Khatta' of North-West India, where it is used extensively as a hedging plant, and the juice of its fruit as an ingredient in pickles and chutney. The 'Khatta' is the Sour Orange of America, where it is largely used as stock for propagation. The second group under *C. aurantium* is the Bergamia, which is the source of oil of Bergamotte, while the third, Sinensis, or ordinary Sweet Orange, embraces such well-known varieties as the Malta, Washington Navel and a great many others.

Citrus nobilis.—This is the Mandarin or Kid-glove Orange (so called on account of its having, in most cases, a thin, tight-fitting skin); or Keonla or Kanwala of India. To this race belong such small, obvate fruited varieties as the China, King, Satsuma, Dancy's, Tangerine and the popular 'Santara,' all of which are closely allied. The leaves of the true Keonla, however, have a different scent to that of these varieties, and when once recognised cannot easily be mistaken.

Citrus decumana.—The two races which have sprung from this species are the Pomelo and the Shaddock. The Pomelo, which was introduced into India from Java, and which is known in the Punjab as the 'Chakotra,' is undoubtedly the more widely distributed race of the species. The trees have dark green foliage, and are vigorous and prolific. Their fruit in India, however, is usually poor—dry and insipid, with a very thick skin. The Shaddock is the largest of all the Citrus fruits, but having an extremely thick skin and bitter juice it is not generally considered edible, and is usually grown simply as a novelty. It is the only Citrus tree which has hairs on the young twigs and underides of the leaves.

Citrus japonica.—Kumquats; all small bushy plants from Cochin China. The fruits are small with mostly acid pulps, and sweet aromatic rinds. They are valuable for preserving.

Citrus medica.—Horticultural races which have originated from this species are the Citron, Lemon and the Lime.

Citron: Varieties of this race are (a) the European, from which the candied citron of commerce is made; (b) the 'Desi Galgai,' which is larger and longer than, but inferior to, the imported citron, and (c) the 'Mokri,' seedling

plants of which as stock are popular among Punjabi nurserymen because of their faculty of producing quickly and easily promising-looking grafts for sale.

Lemon.—The best known varieties which have sprung from this race are the Lisbon, Sicily and the Eureka. Their fruits are smaller than those of the country 'Galgai,' but far superior in flavour.

Lime.—From the Lime race are derived (a) the Kaghzi Lime, of which three types are met with in the markets, *viz.*, the small round variety; the long and medium (said to be the true Kaghzi); the 'Amritsari,' which is the largest, but in flavour the poorest of the three; (b) the Sweet Lime, of which two distinct kinds are found in the markets—the 'Desi' or small fruiting, and the 'Kandhari' or 'Sindhi,' which is the popular "mitha;" (c) the 'Khutti.' Of this there are three distinct kinds, namely, the 'Juthi' or 'Desi Khutti,' which is much in use as a disease-resisting stock; the 'Jullundhri,' a variety producing small fruit which, in the half-ripe state, being scarcely distinguishable from the 'Kaghzi' is frequently mixed with and passed off as the latter by unscrupulous market dealers; the 'Kala Nimbu.' This differs from the previous one in that it has a darker skin. It is brought in large quantities from the vicinity of Peshawar into the Lahore markets, and is also made to pass muster as a 'Kaghzi' Lime.

BOTANICAL CHARACTERISTICS.

Citrus leaves vary in shape and size with the different species, races and varieties, the Poinelo and the Seville Orange having broad wings on the petioles, while the Sweet Orange has a very narrow wing, and the Lemon none at all. The edges of the Sweet Orange leaf are entire, while with the Lemon and the Lime the edges are indented or crenate. One peculiarity of all Citrus leaves is the fact that they have innumerable glands, which are filled with a fragrant and aromatic oil, which is highly volatile and gives to the leaves their extraordinary odour when crushed.

Seedlings of the Sweet Orange have long formidable, thorns; the trifoliate Orange, short thick thorns, which are very numerous. The Navel Orange and Eureka Lemon are thornless varieties.

Citrus flowers are large, showy and fragrant, and bloom profusely. They are generally waxy white, though the Lemon has the back of the petals tinged with purple. The flowers consist of a green calyx with three to five lobes, subtending five to eight white, thick, fleshy petals, which are covered with oil glands. The stamens are numerous—twenty to sixty. The style and stigma are large and conspicuous, and the pollen is golden yellow. In the Punjab the flowering season for nearly all the Citrus family extends from the beginning of March to the end of April, and occasionally into May, an exception being the 'Kaghzi' Lime, on which blooms may be seen at any time throughout the year. Climate and soil, it may be added, have an important influence on the blooming period of the Citrus.

The seeds vary in number from none in the Navel Orange to fifty or more in the *C. trifoliata*.

Citrus wood is very hard, strong and tough. It is light in colour, and distinct rings are observable in a cross section.

The 'sweet stock' often has no tap-root, while the 'sour stock' ordinarily has several. The position of the fibrous feeding roots varies with the depth and quality of the soil. In open, deep soils they may be found as low as 4 or 4½ feet, but as a rule the bulk of plant food is drawn from depths varying from 8 to 36 inches.

